EXHIBIT 8

EXPERT REPORT AND DECLARATION OF PAUL MORGAN PATTISON, Ph.D.

I, Paul Morgan Pattison, Ph.D. declare:

1. I am over 18 and am competent to testify.

2. This declaration is made based upon my knowledge and experience with LED lighting technology and review of ENERGY STAR specifications, Illuminating Engineering Society approved method LM-80 and IES Technical Memo TM-21.

3. If called to testify in this matter, I can and will testify consistent with this declaration.

I. INTRODUCTION AND BACKGROUND

4. I am currently employed by Solid State Lighting Services (SSLS), Inc. as its Founder/President. SSLS is a consulting firm providing technical, strategic, and market expertise in the areas of organic and inorganic light emitting diodes (LEDs), Solid State Lighting (SSL), energy efficient lighting, and the fields of electronic and photonic materials and devices.

5. I am an expert in the technology and characterization of existing and novel lighting technologies, including LED lighting. I received a Bachelor of Science in Electrical Engineering, Electronic Devices and Materials from the University of California, San Diego in 1996. In 2003, I received a Master of Science in Electrical Engineering, Electronics and Photonics from the University of California, Santa Barbara. I received a Ph.D. in Materials Science and Engineering, Electronic and Photonic Materials from the University of California, Santa Barbara, in 2006. For my Ph.D., my area of research was opto-electronic materials and devices, and my specific thesis research was based on the development of advanced gallium nitride based LEDs including design, fabrication, and measurement of the devices. My thesis was entitled: *Fabrication and Characterization of Gallium Nitride Based Micro-Cavity Light Emitting Diodes*.

6. I have nearly 15 years of industry experience in lighting technology and displays including my work as the Project Manager for the DOE Solid State Lighting Program. I have also published numerous articles and given presentations in this field. I am a named inventor on ten U.S. Patents or patent applications. These patents are generally related to lighting devices.

7. I am currently an active member of the Illuminating Engineering Society of North America and I am accredited as 'Lighting Certified' – 'LC' – by the National Council on Qualifications for Lighting Professionals (NCQLP). Through my consulting business, SSLS, Inc., I consult to the U.S. Department of Energy Lighting R&D Program, acting as Senior Technical Advisor. In this capacity, I formulate R&D strategy, manage writing of the annually updated R&D roadmap, review new technologies, and monitor funded R&D projects. On behalf of the DOE Lighting R&D Program, I also manage the LED System Reliability Consortium (LSRC) which is a group of lighting researchers interested in advancing the understanding of reliability of LED lighting systems. I have recently performed contract work for the U.S. National Park Service to review lighting at National Parks and develop preservation-focused lighting strategies.

8. In the past four years, I have provided expert testimony in 2 case(s) related to LEDs and lighting technology: "Certain Light-Emitting Diode Products and Components Thereof," Investigation No. 337-TA-947 (Federal Trade Commission), which was a FTC investigation in which I was retained by Cree, and *SEVEN Networks, LLC v. Google, LLC*, 2:17-cv-00442-JRG (E.D. Tex.), which was a patent infringement case in which I was retained by Google, LLC and provided an exert report and testified in deposition about LED and OLED display technology.

9. **Exhibit A** contains a full list of my publications over the past 15 years.

10. I am being compensated for my testimony in this matter. My hourly rate is $450. My compensation is not contingent in any way upon the outcome of this litigation or the opinions I express.

11. Cree's counsel requested that I provide expert analysis related to the claims that Plaintiff Jeff Young filed against Cree in the instant action. In connection with Cree's filing, to which this declaration is attached, I was asked to explain my understanding of the failure modes that affect LEDs and LED consumer bulbs as well as ENERGY STAR testing and certification requirements and to comment on the expert opinions submitted in this matter by Dr. Gary Allen.

12. A list of documents that I reviewed is attached as **Exhibit B**.

13. In reaching my conclusions, I have drawn not only upon documents related to this case, but also upon my experience and knowledge as an expert in the field of LED lighting technology.

14. As I examine additional materials and perform further analyses, including but not limited to review and analysis of deposition transcripts and other expert reports issued in this matter, I reserve the right to supplement and revise my opinions.

II. SUMMARY OF OPINIONS

15. My opinions in this matter are summarized as follows:

a. Dr. Allen did not establish that Cree LED lamps will commonly fail within one year.

b. Dr. Allen's procedures for testing Cree LED lamps are not industry standard or supported by any literature with which I am familiar.

c. Dr. Allen's method of comparing Cree LED lamps against "Target Maximums" is not industry standard or supported by any literature with which I am familiar.

d. If Cree LED lamps caused LEDs to operate at excessive temperatures, Cree LED lamps would experience premature lumen depreciation or color shift, not catastrophic failure.

III. ENERGY STAR CERTIFICATION AND TESTING

16. In this section I provide some background about ENERGY STAR Certification and testing.

17. The emergence of LED lighting with its high efficiencies and long lifetimes has led to the potential for significant energy and cost savings to our nation as wide-scale adoption occurs. Light emitting diodes (LEDs) are the heart of LED lighting products and can provide long lifetimes that can last well beyond 50,000 hours of operation, longer than most conventional light sources.

18. For most LED products, manufacturers strive to take advantage of the long LED source life to realize a long lived integrated lighting product. There is now widespread

understanding of the degree to which LED drive current and operating temperature (LED and driver) affect system reliability, with better designs as a result. However, a wide range of design choices to meet specific application and market needs are available for LED luminaires, hence a potentially wide range of product life.

19. I am informed and understand that Plaintiff Young alleges in his complaint against Cree that each model of Cree's consumer-oriented LED bulb is advertised to last a specific amount of hours and that these and similar representations on the bulbs' packaging and in Cree's advertising material falsely represent the products' lifetime. Based on my knowledge and experience, I also understand that in order to achieve ENERGY STAR certification, LED bulb manufacturers, and Cree in particular, must validate their lifetime representations using ENERGY STAR testing and performance criteria. In this context, a general overview of ENERGY STAR certification, testing, and packaging requirements is helpful.

e. ENERGY STAR Specifications

20. In 1992, the DOE and EPA introduced ENERGY STAR as a voluntary program to identify and promote energy-efficient products. The ENERGY STAR program covers a wide variety of products and has led to substantive changes in power consumption in the United States.

21. For lighting products ENERGY STAR uses standardized test methods and shape criteria. Participation in ENERGY STAR requires certain minimum performance for several lamp criteria such as luminous efficacy, light output, light distribution, color, lumen and color maintenance, and form factor. Luminous efficacy is the light output in lumens divided by the power consumed to generate that light in watts. Lumen maintenance refers to the amount of light that a lamp emits after operation for a period of time compared to the initial light output. The amount of light that an LED lamp emits decreases over time when operated. Color maintenance refers to the amount to color change of the light over time.

22. The U.S. DOE, Federal Trade Commission, and Federal Communication Commission reference the ENERGY STAR Lamps specification for rules and rule-making. This can be found in Section 6 of Lamps Versions 1.1 and 2.1.

23. In 2010, the DOE introduced an ENERGY STAR specification specifically for LED lamps. This specification provides stringent performance standards as well as test procedures intended to enforce those standards.

24. In August 2013, the EPA announced the release of ENERGY STAR Lamps Version 1.0 Eligibility Criteria, which combined the latest version of the ENERGY STAR specification for LED Lamps (Version 1.4) with the latest version of the ENERGY STAR specification for CFLs (Version 4.3) to create a single, technology neutral specification for all lamps. The Lamps Version 1.0 Eligibility Criteria had an effective date of September 30, 2014. The ENERGY STAR Lamps specification underwent multiple revisions over the years. In May 2014, the EPA announced that it was refining Lamps Version 1.0 Eligibility Criteria to the amended Lamps Version 1.1. This new revision changed the eligibility criteria to re-define omnidirectional lamps. Like Lamps Version 1.0 Eligibility Criteria, Lamps Version 1.1 Eligibility Criteria had an effective date of September 30, 2014. Version 2.0 went into effect in February 2016. Version 2.1, which is the current version, went into effect October 1, 2017.

25. I am informed and understand that Plaintiff Young's claims against Cree span from 2013 to the present to capture the entirety of the time that Cree has manufactured and sold consumer LED bulbs. Cree has thus conducted its ENERGY STAR testing under multiple versions of the ENERGY STAR specifications. I have included the most current specifications Version 2.1 for Lamps (Light Bulbs)[1] of the ENERGY STAR certification requirements and testing.

i. Minimum Life and Testing Requirements Under ENERGY STAR

26. ENERGY STAR certification allows a manufacturer to base life claims for lamps and integrated fixtures on a projection of the lumen depreciation demonstrated at a specific measurement point, provided that lamps are within the color shift specification and no lamps or a

maximum of one lamp (depending on whether Lamps version 2.1 or 1.1 is being used) have catastrophically failed at the applicable measurement point.

27. To qualify for ENERGY STAR certification, lamps must meet an initial light output level at the beginning of their life, corresponding to light levels for an incandescent lamp of the claimed equivalent wattage. It is critical to consumers that a LED lamp rated as a replacement to an incandescent lamp be just as bright as the lamp it is replacing.

28. To measure total light output (also known as luminous flux) for LED lamps, ENERGY STAR uses the standard IES LM-79 measurement which uses absolute photometry to directly measure total lumen output.[2]

29. Lamps are also measured for light output after a prescribed period of operation time to demonstrate that the light output level will not degrade to less than 70% of the initial light output before the claimed lifetime of the lamp. This is lumen maintenance testing.[3]

30. Under the lumen maintenance testing requirements of Lamps Versions 1.1 and 2.1, LED lamps are measured through a 6,000 hour test protocol using the procedures described in the "Lumen Maintenance and Rated Life" section of the ENERGY STAR specification. Lamps are operated for 6,000 hours continuously. At the conclusion of the 6,000 hour test, lamps rated as having a 25,000 hour life must maintain on average 91.8% of their initial light output. This depreciation level corresponds to a linear depreciation of light output that will result in 70% of the

[2] The IES LM-79-08 ("LM-79") test standards are intended to enable objective product comparison, allowing for evaluation relative to performance requirements, and are directly applicable to any LED lamps. These testing standards were created by the Illuminating Engineering Society, and are used by the ENERGY STAR program. LM-79 tests a range of lighting criteria, including electrical characteristics (input voltage, input current, input power, power factor) and optical characteristics (light distribution, lumen output, color quality) to determine efficacy and lighting performance. The ENERGY STAR program further prescribes minimum performance standards for the results of the LM-79 test.

[3] Lamps Version 1.4 prescribes lumen maintenance testing in Section 8; Lamps Version 2.4 prescribes it in section 10.1.

initial light output at the claimed 25,000 life time. Lamps that claim different rated lifetimes will have a different depreciation requirements after 6,000 hours.

31. To pass the ENERGY STAR requirements for lumen maintenance, the ten lamps (five base up and five base down) must be operated for 6,000 hours continuously at a certified test lab and, depending on Energy Star test version, none of the lamps or no more than one lamp can fail during the test. If the average of the surviving lamps is below the required 91.8% threshold, a 3% tolerance may be applied to all measured values at 6,000 hours.

32. The Lamps Versions also mandate the temperatures at which lamps must be tested based on the lamp type, wattage, and labeling—for example, in version 2.1 lamps labeled "not for use in enclosed fixtures" may be tested at lower temperatures than lamps that are not so labeled. Lamps not labeled with this exclusion must be tested at 45ºC. In version 1.1 all lamps that consume greater than 10 watts must undergo life testing at 45ºC.

33. ENERGY STAR requires that certified LED lighting products have a minimum rated life of 15,000 hours.

34. ENERGY STAR testing is an industry standard and commonly used approach for determining and testing rated lifetime of integrated LED lighting products. The ENERGY STAR test procedure evaluates the three primary LED lighting product failure mechanisms--lumen depreciation, color shift, and catastrophic failure—and provides a standard approach for expressing the rated lifetime of LED lighting products.

i. Labeling Requirements Under ENERGY STAR

35. There are a variety of other important criteria mandated by ENERGY STAR, including lamp labeling requirements (Section 15 in Lamps Version 1.1; Section 15 in Lamps Version 2.1). The lamp labeling requirements in particular provide a strong mandate for descriptive packaging, and include posting the nominal CCT, the rated wattage, the rated lumen output, and any application exception language (i.e. "not for use in recessed fixtures").

36. Section 15.3 of Version 2.1 also prescribes a minimum warranty for ENERGY STAR lamps of greater than 3 years for products that claim a rated life of more than 15,000 hours.

Criteria	ENERGY STAR Requirement
General	Packaging and marketing claims shall represent the product consistent with its certification.
Model Number	Lamp packaging shall include model number or retail SKU number consistent with model number or identifying information in the ENERGY STAR listing of certified models.
Controls Compatibility	Lamp packaging exterior shall display on the front panel in ≥ 8 point type an indication of the lamp's dimming capability: "dimmable", "for dimmers", "non-dimmable", "do not use with dimmers" or the like. Dimmable lamp packaging shall indicate that the lamp may not be compatible with all dimmers, and shall reference a website providing regularly updated dimmer compatibility information for the lamp model. Lamps that are dimmable with a limited set of controls, e.g., designed for non-phase cut dimmers, that elect to test and list compatibility with the limited set of controls must list all compatible controls on packaging. Lamps that use the SSL 7A compatibility testing must use the labeling guidelines for SSL 7A complaint products. See Section 12: Dimming. Packaging for lamps not designed for operation with photosensors, motion sensors or timing devices shall indicate in ≥ 8 point type "not compatible with photosensors", "not compatible with timers", "not compatible with motion sensors", "not compatible with photosensors, motion sensors, or timers", or the like.
Application Exceptions	Lamp packaging exterior shall clearly state specific application restrictions (e.g., totally enclosed luminaires, recessed luminaires, insulated ceiling air-tight (ICAT) recessed downlights, damp locations) that would compromise the performance of the lamp and could result in a lamp's noncompliance with the ENERGY STAR specification performance requirements. All application exceptions that appear on the lamp shall also be listed on the lamp package exterior. (≥ 8 point type and/or bold text is recommended.) LED MR Lamps Intended for use on Low-Voltage Circuits: Lamp package must state compatibility with low-voltage transformers. Lamp package and product information sheet must include a caution label indicating the lamp may not be compatible with all low-voltage transformers used in existing light fixtures and identifying the Web address (URL) to find up-to-date low-voltage transformer compatibility and appropriate use information. A voltage waveform (AC or DC) for which a low voltage MR lamp does not provide the certified performance shall be considered an application exception which shall be detailed on lamp packaging: "Not intended for AC operation." or "Not intended for operation on AC transformers." or "Not for use with AC transformers." or the like, where "DC" may be substituted for "AC", as applicable.
Restricted Position	If lamp is tested in a limited orientation, lamp packaging shall indicate the performance ratings are based on that orientation as applicable (e.g., base up only).
Minimum Starting/ Operating Temperature	Lamp packaging shall state the minimum starting or operating ambient temperature and shall state any other conditions required for reliable starting as designated by the partner.
Warranty	Lamp packaging shall include warranty information see Warranty Requirements Section of this specification.
CCT Descriptor	If packaging includes a color descriptor term, EPA recommends the following corresponding nomenclature as outlined below. • 2200K – Amber Light • 2500K – Sunset Light • 2700K – Soft White • 3000K – Warm White • 3500K – Neutral White • 4000/4100K – Cool White • 5000K – Daylight • 6500K – Daylight

IV. LED LAMP RELIABILITY: FAILURE MODES

37. LED lighting products can have a greater range of reliability compared to previous lighting technologies. The design space is sufficiently broad that products with nominally the same appearance, such as replacement A-lamps, may have dramatically different lifetimes and reliability. The differences may be a result of design choices including LED selection, LED drive current, materials and assembly, electronic component choices, or other aspects of the design.

These design choices can affect LED operating temperature as well as other factors that influence reliability, including lumen depreciation, catastrophic failure, and color shift.

38. To accurately characterize the reliability performance of any product, it is important to identify and understand those failure modes that materially affect it.

39. I am familiar with typical failure modes of LED lighting products by reason of my training, education, and experience with LED lighting products. I have been directly involved with evaluating aspects of LED lighting product reliability since 2006. In particular, I have managed DOE funded R&D on the topic of LED system reliability and since 2013 I have contributed to and managed the development of LED lighting reliability guides developed through the LED System Reliability Consortium.[4]

40. There are three primary failure mechanisms for LED lighting products. First, an LED lighting product's light output levels can degrade over time to the point where the product is no longer considered to be an effective light source. An LED lighting product is usually considered to be ineffective when the light output is 70% or less of the initial light output of the product, known as the lighting product's L70 lifetime. Even for products that are not ENERGY STAR certified, product lifetime is typically rated in terms of lumen depreciation to 70% of initial lumen output.

41. Second, the color of the light from the lighting product can shift to an unacceptable level. This is known as color shift. The level of acceptable shift depends on the lighting application.

42. The third failure mechanism is catastrophic failure (sometimes referred to as operational failure), which occurs when some component within the lighting product fails to the extent that the lamp no longer emits any light. This is typically due to a failure in the power supply

[4] A sample of the developed reliability guides can be found at these links.
https://www.energy.gov/sites/prod/files/2015/01/f19/led_luminaire_lifetime_guide_sept2014.pdf

https://www.energy.gov/sites/prod/files/2019/10/f67/lsrc_colorshift_apr2017.pdf

of the LED lighting product. The role of the power supply is to convert line voltage (AC power from the electrical system in a home or building) to DC power that is suitable to power the LED circuit within the lighting product. LED power supplies can fail due to high temperature, sub-optimal component selection within the power supply, power surges, manufacturing errors, environmental causes (such as animal ingress), or a combination of these factors.

43. Catastrophic failure examples include power supply failure, corrosion of an electrical connection that stops the electrical flow to critical components, or breakage of a critical part due to vibrations or stresses beyond what the luminaire can handle. Many additional factors can affect the rate of lumen depreciation or the likelihood of catastrophic failure.

44. These include temperature extremes, humidity, chemical incursion, voltage or current fluctuations, failure of the driver or other electrical components, damage or degradation of the encapsulant material covering the LEDs, damage to the interconnections between the LEDs and the fixture, degradation of the phosphors, and yellowing of the optics.

45. In addition, abrupt semi-random short-term failures may be observed due to assembly, material, or design defects

46. One abrupt failure mechanism at the LED package level is the loss of electrical connections through mechanisms such as a broken wire bond or an open solder joint. Other potential failure modes at the LED level include loss of emitter sites due to defect propagation, die cracking, phosphor delamination, and contact or silver mirror corrosion. All of these mechanisms are impacted by temperature, humidity and current. Finally, electrostatic discharge (ESD) and electrical overstress (EOS) can also produce abrupt failures at the LED package level through damage to the emitter layer or device interconnections.

47. Manufacturers usually can provide extensive data on the performance and reliability of LED packages. There has been great progress in minimizing abrupt failures in LEDs, and field experience suggests they are not a significant factor in overall product reliability, provided good manufacturing practices are followed and the product is designed within the limits of the LED package.

48. The reliability of LED packages, in terms of lumen maintenance and color shift, can be predicted based on well understood and standardized testing of packages at a range of current densities and operating temperatures (LM-80). This data can be used to predict the reliability of the LEDs based on the applied current and operating temperature when they are integrated into the lighting product, such as a lamp.

49. Manufacturers can project the reliability and claim a rated lifetime of ENERGY STAR certified lamps according to standard ENERGY STAR test procedures (the "Lumen Maintenance and Rated Life" criteria) after samples of the lamps are operated for an extended period of time (typically 6000 hours) to determine that the lighting product will last for the claimed lifetime. All LED lamp models that claim ENERGY STAR certification must go through this testing process. ENERGY STAR lighting products designed to operate at elevated temperatures, typically in a recessed fixture, are tested at 45ºC for 6000 hours. According to current ENERGY STAR labeling requirements, lighting products not intended to be operated at elevated temperature must be labeled as such and will undergo extended duration testing at 20-35ºC.

50. Under the latest version of ENERGY STAR published requirements, ENERGY STAR certified lighting products must have a minimum rated life of at least 15,000 hours.

V. REVIEW OF DR. ALLEN'S REPORT

Analysis of Dr. Allen's Findings and Conclusions.

51. Dr. Allen finds and concludes that several models of Cree lamps misrepresent their rated lifetime and will "commonly fail within a year." His conclusions are not supported by data or analysis.

52. Dr. Allen does not present any evidence that indicates that Cree lamps will "commonly fail within a year." It is my opinion that if Cree lamps commonly failed within one year of operation, the lamps could not have achieved ENERGY STAR certification.

53. The rated life of the ENERGY STAR certified Cree lamps is based on standard ENERGY STAR requirements and validated by ENERGY STAR testing at a certified test laboratory. In order to achieve ENERGY STAR certification, the Cree lamp models underwent

testing either at 20-35ºC or 45ºC depending on the ENERGY STAR specification version at the time of certification and whether the product is labeled as suitable for enclosed fixtures. Under ENERGY STAR Program Requirements, the lamps were operated for 6,000 hours— or almost ¾ of a year—and could not have catastrophically failed (or had just one failure), exhibited excessive light output depreciation, or excessive color shift and still obtained ENERGY STAR certification. ENERGY STAR testing validates the Cree product reliability in terms of lumen maintenance, color shift, and catastrophic failure and allows the products to claim the associated lifetime.

54. By reason of my experience, education, and training, I am familiar with industry standards related to validation of reliability of LED lighting products.

55. ENERGY STAR validation, or similar testing and life projections, is the preeminent industry standard test to validate the reliability of LED Lighting products and rate the claimed lifetime of LED lighting products.

56. By reviewing Dr. Allen's report and deposition testimony, I am aware that Dr. Allen tested a sample of Cree LED lamps after the lamps operated for approximately 2.5 hours, and took various temperature measurements that he then compared against "Target Maximums," which he described as conservative temperature limits that LED lamp designers should aim to achieve.

57. I am not aware of any industry standard, published guideline, or literature that supports Dr. Allen's methodology of testing LED lamps and the evaluation criteria that he uses. Rather, Dr. Allen bases his opinion on non-standard test and evaluation procedures and criteria that are not industry standard.

58. More specifically, I understand from Dr. Allen's opinion is that Cree should have designed its LED lamps so that certain components, including the LEDs, operate below the manufacturers' rated temperature for a given rated lifetime.

59. LM-80 reports the LED components' actual lumen maintenance after 6,000 hours of testing at several operating temperatures. LED lamp manufacturers can use this information to design products that will achieve desired rated lifetimes.

60. Dr. Allen states that in his opinion, Cree should have designed Cree LED Lamps to operate below the rated temperature on the LM-80 for a given rated lifetime.

61. Dr. Allen does not cite to any industry standard, published guideline, or literature to support his opinion that Cree should have designed lamps to ensure that LEDs operated below the maximum operating temperature tested on LM-80.

62. I am not aware of any industry standard, published guideline, or literature that states that lamp designers should design lamps to ensure that LEDs operate below the rated operating temperatures set forth on the LED's LM-80 report to achieve a desired rated lifetime.

63. Dr. Allen's in-house, non-standard testing and evaluation actually corroborate likely lumen maintenance results, per LM-80, and demonstrate the Cree products are meeting their design targets. In paragraph 26 of his report he describes that "Although the CREE XB-G LED lumen maintenance exceeds the minimum specification of 91.8%, the margin is only 1.4%..." This shows that in this case, Cree products, according to Dr. Allen's analysis, exceed the expected lumen depreciation for the rated product lifetime. In my experience, there is no expectation or incentive for any manufacturer of an ENERGY STAR lighting product to claim performance less than what is allowable according to Energy Star lifetime rating standards.

Dr. Allen Tested an Insufficient Number and Variety of Lamps.

64. ENERGY STAR reliability testing requires that 10 samples of each ENERGY STAR certified lamp model are tested for long term lumen maintenance, color shift, and catastrophic failure over 6,000 hours. In contrast, Dr. Allen tested 2 samples of 5 lamp models at one moment in time. In addition, through the course of his testing, Dr. Allen disassembled one of the samples of each lamp type which can affect the thermal properties of the assembly and distort the findings.

65. Dr. Allen compounds this limitation by projecting his findings to a vast number of additional Cree LED lamps. Dr. Allen's methodology of applying his findings related to 10 total lamp samples at one moment in time across an entire suite of LED lamps is not industry standard. Dr. Allen does not cite to any industry standard, published guideline, or literature to support his

opinion that he can apply results from 10 lamp samples to all of the LED lamps that Cree manufactures.

66. I am not aware of any industry standard, published guideline, or literature that states that it is appropriate to extrapolate reliability results from 2 lamps of 5 models at one moment in time to many of the lamp models that Cree manufactures.

67. Dr. Allen's methodology for classifying Cree LED Lamps is contrary to other industry standards for grouping LED lamps for evaluation, including ENERGY STAR guidelines (which are industry standard guidelines for evaluating expected lifetime of LED lamps).

68. For example, Dr. Allen's "FT19" Lamp Architecture includes 40-, 60-, and 75-watt replacement lamps. Allen Report ¶ 15(2). In other words, Dr. Allen opines that 40-, 60-, and 75-watt lamps can be commonly evaluated for lifetime and reliability expectations. ENERGY STAR Program Requirements do not, however, allow lamp manufacturers to commonly submit ENERGY STAR applications for 40-, 60-, and 75-watt replacement lamps. Rather, ENERGY STAR Program Requirements provide that a manufacturer must submit separate data for each wattage replacement of a particular lamp type. Dr. Allen's methodology for grouping Cree LED Lamps for lifetime evaluation is, therefore, contrary to industry standards.

69. Ultimately, the analysis and testing that Dr. Allen performed is not at all sufficient to override the standard ENERGY STAR test results and resulting life rating allowed by ENERGY STAR for either the models that were tested or the untested models.

Dr. Allen Failed to Account for Variation in LED Performance.

70. Dr. Allen's testing and analysis purports to analyze the thermal performance of the Cree LED lamps, but the testing does not consider the substantial impact that variations in LED efficiency will have on the performed thermal measurements and resulting analysis. The LEDs are the components that generate the heat based on how efficiently they convert electricity to light. Different Cree lamp models will likely use different caliber LEDs with different efficiency levels, greatly affecting the performed temperature measurements.

71. Even lamp models emitting light at different color temperatures will require different LEDs which will have different efficiency levels. For example, an LED emitting 'warm white', lower CCT white light will experience greater phosphor conversion losses resulting in lower efficiency, compared to an LED emitting 'cool white', higher CCT white light. For this reason, the U.S. DOE separately tracks LED efficiency for these different colors. This efficiency performance tracking can be found in the annually updated DOE roadmaps.[5] By not considering the impact of different LED efficiency levels, Dr. Allen's findings, such as they are, can only apply to the specific tested products and cannot be extended to products that are using different LEDs with different efficiency levels and resulting different amount of heat generation.

Dr. Allen's Tests and Conclusions Relate to an Irrelevant Failure Mode.

72. If Dr. Allen is correct and Cree is operating LEDs at extreme temperatures, Cree lamps would not experience catastrophic failure. Rather, the Cree lamps would experience lumen depreciation and color shift. My understanding is that the plaintiff in this matter has complained about catastrophic failure which, in my experience, is almost never due to LED failure, but is more likely due to manufacturing or materials problems, improper operation of the lamp, or environmental conditions. Therefore, all of Dr. Allen's testing and analysis of LED temperature in the lamp would only be relevant for complaints of early lumen depreciation or color shift.

73. Despite claiming that Cree lamps will commonly fail within a year of purchase, Dr. Allen does not provide any actual evidence that Cree lamps will, in fact, fail (or have failed) this early. Dr. Allen does not support this claim by showing evidence of widespread product failure.

74. This claim by Dr. Allen is also belied by ENERGY STAR requirements which test samples for 6,000 hours of continuous operation which is equivalent to about ¾ of a year. If these lamps were operated under typical conditions and for 3 hours per day it would take over 5 years of operation to reach 6,000 hours of product on-time. ENERGY STAR testing is designed to show

[5] I am lead author of the DOE Lighting R&D roadmap which tracks LED performance. The most recent version of this document can be found at this link - https://www.energy.gov/sites/prod/files/2020/01/f70/ssl-rd-opportunities2-jan2020.pdf

that the LED products will last much longer than 6,000 hours of operating time. The results of Dr. Allen's non-standard testing and analysis of a handful of lamps directly conflicts with the fact that the Cree lamps successfully passed the required ENERGY STAR lumen maintenance and rated life testing. ENERGY STAR labeling allows for claims of rated life based on successful completion of standard ENERGY STAR testing in a certified test lab. However, characterization of the reliability of LEDs and LED based lighting products is imperfect. As with previous technologies, not all LED lighting products will live up to their rated lifetime and they may catastrophically fail. This can be due to manufacturing or materials defects, improper usage of the lamps, or environmental conditions such as moisture, chemical, or even animal exposures. For these instances of failure, ENERGY STAR requires that manufacturers provide a warranty for at least 3 years. The Cree products at issue all have warranties of at least 5, and as many as 10, years. Dr. Allen's test results and analysis do not show a fundamental design problem with the Cree products that he tested. Rather, the testing shows that the Cree products are operating as designed and will likely meet ENERGY STAR test requirements and can claim the associated rated lifetime according to ENERGY STAR requirements.

75. As I examine additional materials and perform further analyses, including but not limited to review and analysis of deposition transcripts and other expert reports issued in this matter, I reserve the right to supplement and revise my opinions.

This the 14th day of February, 2020.

Paul Morgan Pattison

EXHIBIT A

LEDs for photons, physiology and **food.** Pattison, PM, Tsao, JY, Brainard, GC, Bugbee, B. (2018) *Nature*. 563, 493-499.

LED lighting efficacy: Status and directions. Pattison, PM, Hansen, M, Tsao, JY. (2018) *Comptes Rendus Physique*. 19, 134-145.

Energy Savings Potential of SSL in Horticultural Applications. Stober, K, Lee, K, Yamada, M, Pattison, M. (2017)

Department of Energy Solid State Lighting R&D Opportunities/Plan, *lead author* (2018, 2017, 2016, 2015)

Light-emitting diode technology status and directions: opportunities for horticultural lighting. Pattison, PM, Tsao, JY, Krames, MR. (2016) *Acta Horticulturae***.** 1134, 413-426.

Status of SSL Product Development and Future Trends for General Illumination. Katona TM, Pattison PM, Paolini S. (2016) *Annual Review of Chemical and Biomolecular Engineering* 7 (1).

The Blue LED Nobel Prize: Historical context, current scientific understanding, human benefit. Tsao, J, Han, J, Haitz, R, Pattison, PM. (2015) *Annalen der Physik* 527, No. 5–6, A53–A61.

Department of Energy SSL R&D Multi-Year Program Plan (2008-2014)

Department of Energy SSL Manufacturing Roadmap (2009-2014)

Gallium nitride based microcavity light emitting diodes with 2 lambda effective cavity thickness. Pattison, P. M., David, A., Sharma, R., Weisbuch, C., DenBaars, S., & Nakamura, S. (2007). *Appl. Phys. Lett*, *90*, 031111.

First-moment analysis of polarized light emission from InGaN/GaN light-emitting diodes prepared on semipolar planes. Masui, H., Baker, T. J., Sharma, R., Pattison, P. M., Iza, M., Zhong, H., Nakamura, S., & DenBaars, S. P. (2006). *Japanese journal of applied physics*, *45*(9L), L904.

Gallium nitride based micro-cavity light emitting diodes emitting at 498 nm. Pattison, P. M., Sharma, R., David, A., Waki, I., Weisbuch, C., & Nakamura, S. (2006). *Physica Status Solidi (a)*, *203*(7), 1783-1786.

Demonstration of a semipolar (10 (1) over-bar (3) over-bar) InGaN/GaN green light emitting diode. Sharma, R., Pattison, P. M., Masui, H., Farrell, R. M., Baker, T. J., Haskell, B. A., Wu, F., DenBaars, S.P., Speck, J.S., & Nakamura, S. (2005). *Applied Physics Letters*, *87*(23).

Micro cavity effect in GaN-based light-emitting diodes formed by laser lift-off and etch-back technique. Fujii, T., David, A., Schwach, C., Pattison, P. M., Sharma, R., Fujito, K., Margalith, T., DenBaars, S.P., Weisbuch, C., & Nakamura, S. (2004).. *Japanese journal of applied physics*, *43*(3B), L411.

292 nm AlGaN single-quantum well light emitting diodes grown on transparent AlN base. Hanlon, A., Pattison, P. M., Kaeding, J. F., Sharma, R., Fini, P., & Nakamura, S. (2003). *Japanese journal of applied physics*, *42*(6B), L628.

Higher efficiency InGaN laser diodes with an improved quantum well capping configuration. Hansen, M., Piprek, J., Pattison, P. M., Speck, J. S., Nakamura, S., & DenBaars, S. P. (2002). *Applied physics letters*, *81*(22), 4275-4277.

What's next for LEDs. Pattison, PM (2019) *Electroindustry.* March/April 2019.

Building the evidence outside the lab. Pattison, PM (2018) *Lighting Design & Application.* December.

LEDs for Horticulture: More than Meets the Eye. Pattison, PM. (2018) *Lighting Design & Application.* August.

EXHIBIT B

In addition to documents cited in my declaration, I reviewed the following:

1. Complaint
2. Amended Complaint
3. Renewed Motion for Class Certification
4. Expert Report of Gary R. Allen Ph.D., with exhibits
5. Deposition of Gary R. Allen Ph.D., with exhibits
6. First Declaration of Jon Vollers, with exhibits
7. Supplemental Declaration of Jon Vollers, with exhibits